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September 15, 2005

Marlene H. Dortch, Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

RE: WT Docket Nos. 04-356 and 02-353
Notice of Ex Parte Presentation

Dear Ms. Dortch:

This is to inform you that on September 14, 2005, in connection with the above-referenced proceedings, the undersigned, representing Agilent Technologies ("Agilent"), and William Mueller, Strategic Marketing Manager of Agilent's Wireless Semiconductor Division, met with Peter Daronco, David Hu, Jennifer Tomchin, Marty Liebman, Peter Corea, Stephen Zak, Blaise Scinto and Tom Stanley of the Wireless Bureau and Ira Keltz, Ron Chase, Ahmed Lahjouji, Salomon Satche and Patrick Forster of the Office of Engineering and Technology. The purpose of the meeting was for Agilent to provide information regarding the state of technology for cell phone handset filters, and specifically the use of that technology in H Band handsets.

The attached PowerPoint presentation was made to the meeting participants and summarizes the substance of Mr. Mueller's remarks.

Please direct any questions to the undersigned.

Respectfully submitted,

Laura Stefani

Laura Stefani
Attorney for Agilent Technologies

Enclosure

cc: Peter Daronco
David Hu
Jennifer Tomchin
Marty Liebman
Peter Corea
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Comments on Filtering for H Block

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September 9 2005

Agilent Technologies

Request for Participation

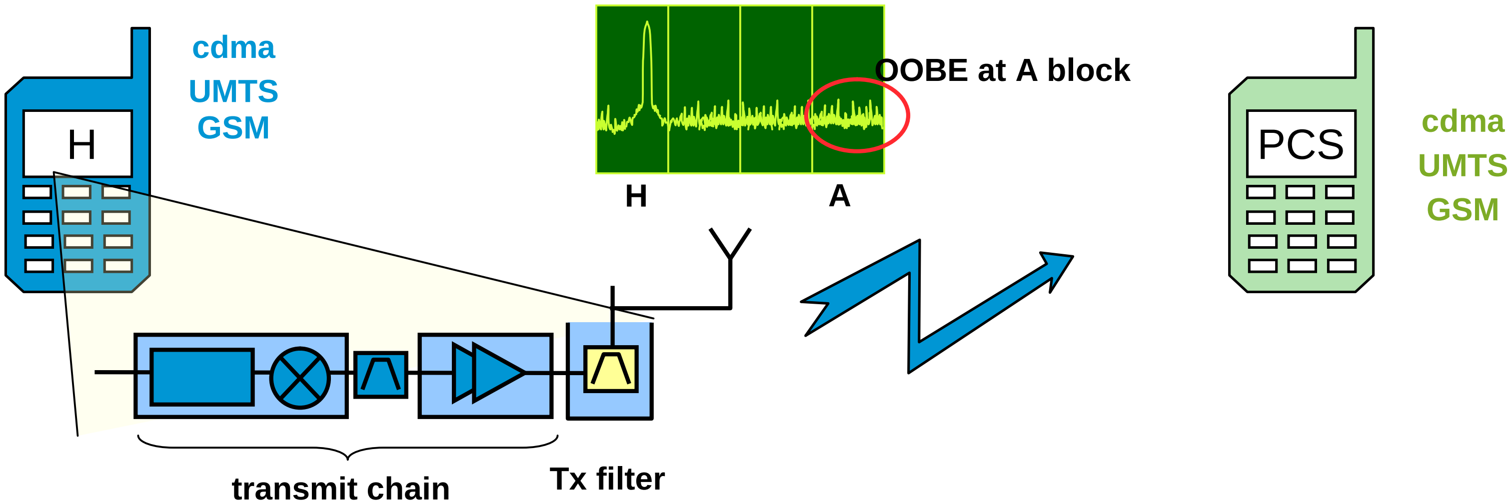
The FCC requested comments on the following questions:

1) Does Agilent still believe that the -76dBm/MHz out of band emission limit for the handsets cannot be achieved?

2) Does Agilent believe that a -76dBm/MHz RMS emission limit can be achieved for the handsets? Sprint and Nextel claim it is possible.

3) If Agilent does not believe that either of the above is possible, what do we think would be an achievable emission limit?

OOBE (Out Of Band Emissions)



The signal transmitted by an H block handset *outside H block* must leave the handset at an acceptably low level. This is effected by:

- Characteristics of the transmit chain of the H block handset
- Attenuation provided by the Transmit (Tx) filter of the H block handset
- Transmit signal strength

Protection from ACMD-7402 FBAR filter

Curve is from measured data of an ACMD-7402 Tx filer, re-centered for 3 dB loss at +85

Typical filter provides ~35 dB protection 10 MHz away from the 3 dB IL point at room temperature

Production variation across filters causes worst filters to provide ~30 dB protection 10 MHz away from the 3 dB IL point at room temperature

At cold temperature (-30 C), the worst filters provide ~16 dB protection 10 MHz away from the 3 dB IL point

present technology FBAR Tx filters can provide:

~ 16 dB rejection over temperature from the top of H block (1920 MHz).

~ 39 dB rejection over temperature for the first 2 MHz of H block (1917 MHz).

Note that the amount of attenuation changes significantly across H block, and substantially more protection is provided in the lower third of the band than in the upper third.

Does Agilent still believe that the -76dBm/MHz out of band emission limit for the handsets cannot be achieved?

Agilent has not represented that a -76dBm/MHz out of band emission limit for the handsets cannot be achieved.

What Agilent has represented is that present duplexer technology is insufficient to create a commercially viable single duplexer that could simultaneously cover A through H block. We still believe this is true. However we do not believe this circumstance is sufficient to imply than a -76 dBm/MHz emission limit cannot be achieved.

Does Agilent believe that a -76dBm/MHz RMS emission limit can be achieved for the handsets? Sprint and Nextel claim it is possible.

Agilent believes that it is likely that a -76dBm/MHz RMS emission limit can be achieved for H block handsets.

The emission limit is not solely a function of the transmit (Tx) filtering, it also depends on the characteristics of the transmit chain. In some cases, the transmit chain is clean enough, and no help is required from Tx filtering.

Present filtering technology is demonstrably capable of providing a minimum of 16 dB of protection 10 MHz from the transmit frequency. We believe that additional protection, on the order of 10 dB or so, can be achieved with design focus or minor tradeoffs in filter insertion loss.

From what Agilent WSD understands of present system capability, we believe it is likely this is sufficient filtering to enable a -76 dBm/MHz emission limit to be met. However Agilent WSD should not be considered the final authority on systems capability.

If Agilent does not believe that either of the above is possible, what do we think would be an achievable emission limit?

Agilent believes that the question about interoperability of H block handsets and PCS handsets is broader than determining at what level the OOBE emission limit should be set for H block handsets.

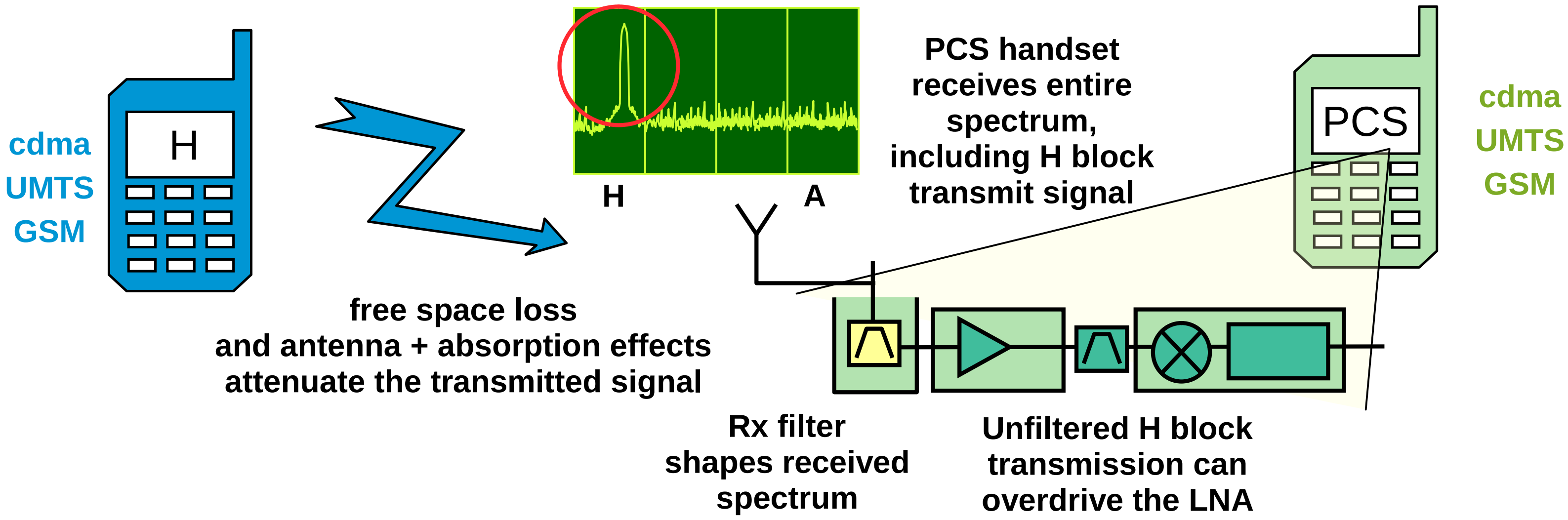
Areas of concern include:

1. The transmit signal from a H block handset might appear at the receiver of a nearby PCS handset at sufficient strength to degrade reception.

2. The transmit signal from an H block handset might mix with the transmit signal from a nearby PCS handset to create an intermodulation distortion (IM) signal that can degrade reception in the PCS handset.

3. The transmit signal from an H block handset might leak back into a PCS receiver *in the same handset* and degrade the performance of that receiver.

OD (Overdrive)



The signal transmitted by an H block handset *at H block* must reach a PCS handset at an acceptably low level to not overdrive the LNA. This is effected by:

- Transmit signal strength
- Attenuation provided by free space loss and antenna shaping / absorption effects
- Filtering provided by the receive (Rx) filter of the PCS handset
- The Input Intercept Point (IIP3) of the LNA in the PCS handset

How much protection do existing filters pr

Filter Type	1920 MHz typical 25C dB	1920 MHz worst 25C dB	1920 MHz worst 85C dB	1917 MHz typical 25C dB	1917 MHz worst 25C dB	1917 MHz worst 85C dB
Older FBAR HPMD-7904	8	6	5	19	13	8
Present FBAR ACMD-7401	30	22	10	56	42	34
Next FBAR ACMD-7402	27	20	15	47	43	36
Present SAW	13	11	10	25	20	14
Ceramic CTS CER0111A2	15	12	11	24	20	19
GSM SAW Epcos B9008	6	4	2	10	8	3

Estimate of filter performance for major classes of filters in use in today's handsets based on data sheet characterizations and measurements. Detail in Appendix

Observations

There is a lot of variability in what protection filtering presently in handsets will provide.

GSM handset have the least protection. However receive filter requirements are far more relaxed for GSM than for cdma or UMTS. This might be an indication that overdrive may be a less serious problem for GSM. System specialists should be consulted to determine if the lack of filtering at H block poses a problem for GSM receivers.

The filters in use typically provide significantly more protection in the lower portion of H block than they do in the upper portion.

Newer technology provides more protection than older technology.

How much protection is needed?

If self jamming is taken as a model, then the maximum Tx power (25 dBm) minus the isolation of the duplexer (50 dB minimum) suggests -25 dBm can be tolerated by most receivers.

Measurements of actual handsets have shown lower thresholds. A -29 dBm level might be more typical, and numbers as low as -36 dBm have been measured.

One suggested model for minimum loss between interacting handsets is 41 dBm (38 dBm/m x 1 meter, + 3 dB antenna and absorption effects).

This suggests that protection from filtering should be in the 13 dB to 20 dB range to be reasonably immune to overdrive.

These numbers should be confirmed by systems experts!

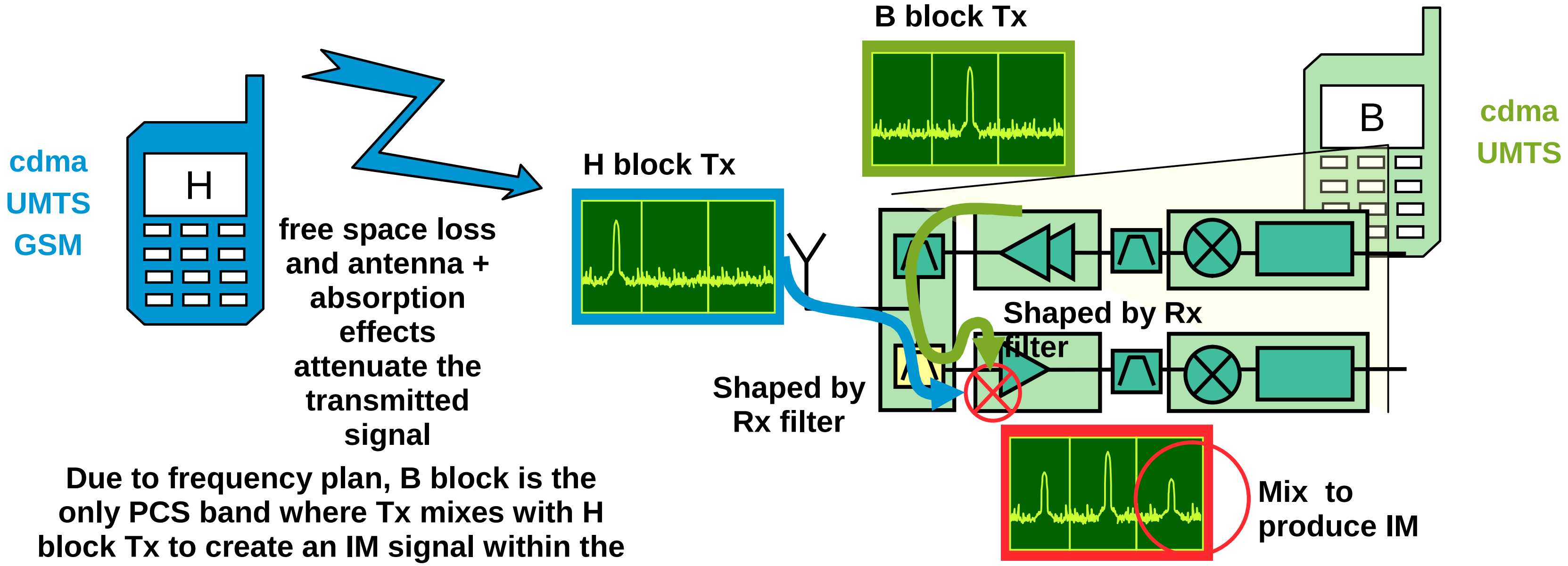
Conclusions on Overdrive

Filtering in an H block handset doesn't help reduce the probability of overdrive.

Filtering technology available today is probably good enough to protect handsets against overdrive, at least from transmission originating in the bottom third of H block.

This level of performance is not yet found in all PCS handsets in service. Examination of Rx filtering presently in handsets suggests that without transmit power limitations, overdrive is likely to occur, especially from transmissions originating from the upper portions of H block.

IM (Intermodulation Distortion)



Due to frequency plan, B block is the only PCS band where Tx mixes with H block Tx to create an IM signal within the receive band.

Intermodulation products created when H block Tx signals mix with leakage of B block Tx signals in the B block handset receiver must be low enough to not create unacceptable distortion in the B block receiver. This is effected by:

- Transmit signal strength
- Attenuation provided by free space loss and antenna shaping / absorption effects
- Filtering provided by the receive filter of the B block handset, both in H block and in B block
- The linearity characteristics of the receiver of the B block handset

Filtering and IM protection

Precise analysis of intermodulation is difficult, and Agilent believes that measurements, not calculations, should be used to determine appropriate levels.

From theory, for every dB of improvement in the rejection of the Rx filter of the B block duplexer at H block, the IM should reduce 2 dB. For every dB improvement in the rejection of the Rx filter of the B block duplexer at B block, the IM should reduce 1 dB.

Measurements suggest IM is a more severe problem than overdrive. In one test, received signals in the -30 to -41 dBm range caused significant distortion due to intermodulation. These same handsets exhibited significant distortion from overdrive at power levels that were 1 to 13 dB higher. Thus simplistically up to 13 dB rejection beyond the levels required by overdrive might be needed from the Rx filters to alleviate IM problems.

As with other distortion mechanisms, filtering can be expected to provide significantly more protection against IM from transmissions originating in the lower portion of H block than from transmissions originating in the upper portion.

Conclusions on IM

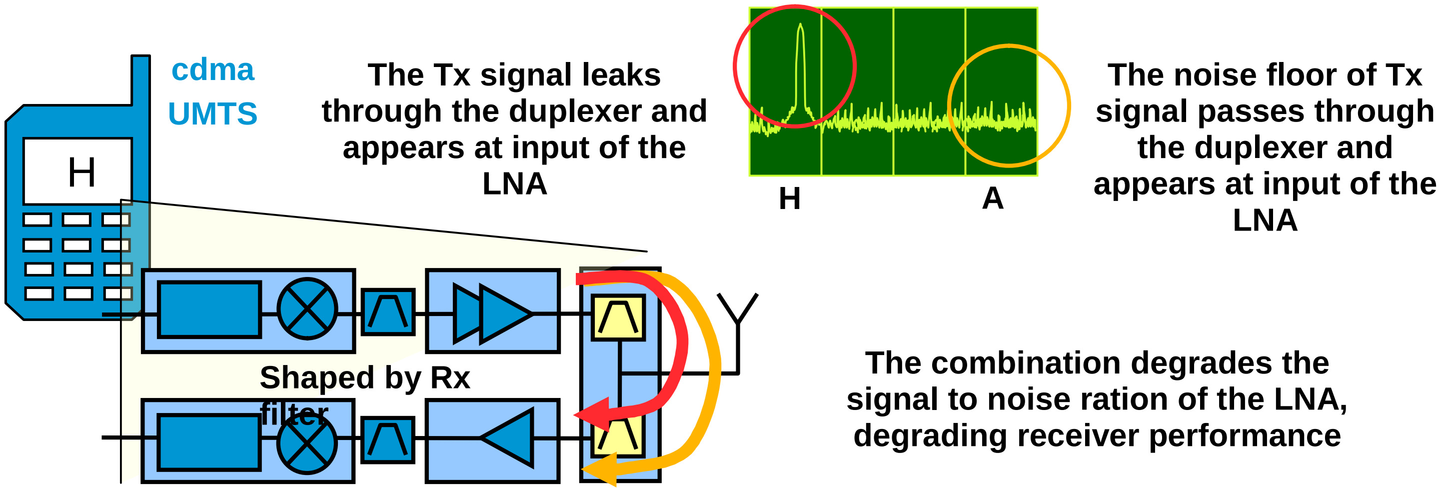
IM distortion is a more severe problem than either OOBE or OD.

Filtering in an H block handset doesn't help reduce the probability of distortion from IM.

It's not certain whether today's filtering technology is good enough to completely protect against IM. It is more probable that it is adequate to protect against transmissions in the bottom portion of H than against transmissions from the top portion of H.

The filtering found in handsets presently in use is not adequate to protect again IM without placing limitations on H block transmit power. Agilent WSD believes measurements, not theory, should be used to determine what power level would be appropriate.

Self Jamming



Self jamming occurs when the leakage of the H block Tx signal through the duplexer and/or the noise power of the Tx signal in the Rx band appears at the handset's LNA at sufficient strength to degrade signal to noise level to an unacceptable level. This is effected by:

- Transmit signal strength
- Attenuation of duplexer Tx Filter (removes noise) and Rx filter (removes Tx leakage)
- IIP3 of the LNA
- Handoff operation of handset (Rx bands being "listened to" during Tx)

Filters and Self Jamming

Today's technology is not sufficient to create a single duplexer that will protect a handset transmitting in H block from self-jamming in A block.

Additional complexity added to the architecture (e.g. the use of 2 duplexers and switches) can permit this kind of operation. However the requirements on the switching can be onerous and will likely result in a handset with reduced talk time and much higher complexity.

Two duplexer architectures for handsets NOT requiring simultaneous reception in A block and transmission in H block are straightforward, and should have little penalty in performance.

Creating a single duplexer that can simultaneously cover A through H block requires advances in temperature compensation. Research suggests that temperature compensation may be possible, but is not certain, and has not yet been demonstrated in high volume production. It is premature to assume a single duplexer covering A through H will be available to designers in the future.

Conclusions on Self Jamming

Self-Jamming only effects the H Block handset

Present filtering isn't good enough to prevent self jamming in a handset covering A through H blocks with a single duplexer.

Architectural changes and handoff control can solve self jamming.

Ways to Prevent Possible Interference

Places where filtering can help prevent possible interference are indicated in red.	H block handset	PCS "victim" handset
OOBE	Tx filter Tx chain cleanliness reduced Tx power	no effect
Overdrive	reduced Tx power	Rx filter IIP3 of LNA
IM (doesn't effect GSM victims)	reduced Tx power	Rx filter in duplexer Receiver linearity
Self Jamming	reduced Tx power Tx filter Rx filter	not applicable

How Much Filtering Can Help

Estimated protection available from filtering, using "worst" over temperature case. "is" = deployed; "can be" = technology limit	H block handset 1917	H block handset 1920	PCS "victim" handset 1917	PCS "victim" handset 1920
OOBE	can be 39 dB	can be 16 dB	not addressable with filtering in the victim handset	
Overdrive	not addressable with filtering in the H block handset		is 8 dB cdma is 3 dB GSM can be 36 dB	is 5 dB cdma is 2 dB GSM can be 15 dB
IM (doesn't effect GSM victims)	not addressable with filtering in the H block handset		is 8 dB can be 36 dB	is 5 dB can be 15 dB
Self Jamming	can be 39 dB need >50 dB	can be16 dB need >50 dB	does not apply to a victim handset	
	solve with architecture			

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Overall Conclusions

1. OOBE of -76 dBm/MHz should be possible for an H Block handset using today's technology. This is within the control of the H block handset.
2. Overdrive from an H block handset can potentially interfere with a PCS receiver. Rx filtering presently in potential victim handsets is not adequate to protect against overdrive. Filtering technology good enough to build RX filters that would provide adequate protection already exists.
3. H block handsets can potentially cause IM distortion in B block receivers. Rx filtering presently in potential victim handsets is not adequate to protect against IM. It is uncertain if today's filtering technology is adequate to protect against IM.
4. For OOBE, Overdrive, and IM, the circumstance can be significantly different for the lower third of H block compared to the upper portion of the band, in that filtering typically is substantially better in the bottom portion of the band.
5. Self Jamming considerations between H block and PCS will arise if simultaneous use is necessary for handoff. Limitations in duplexer technology require the use of more complex architectures than those presently used by PCS handsets to avoid self jamming. Self jamming does not effect other handsets.

Appendix

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What a Duplexer Does

To allow simultaneous transmission and reception in the same handset:

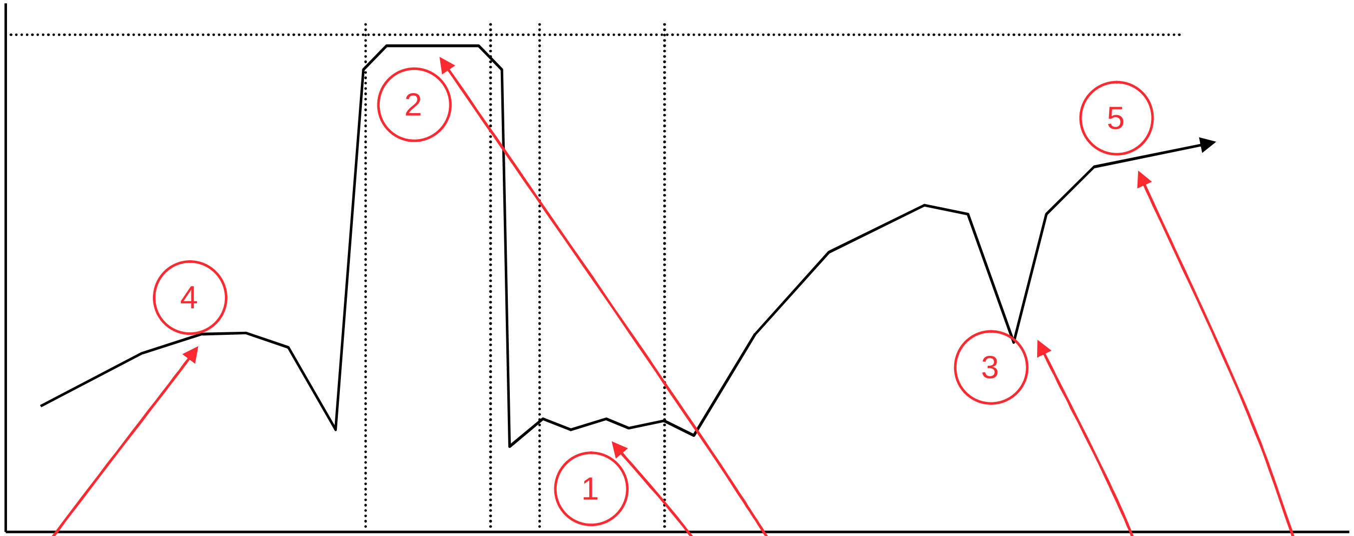
- The rejection of the duplexer Rx filter in the Tx band prevents leakage of Tx signal into the receiver.
- The rejection of the duplexer Tx filter in Rx band prevents leakage of Tx noise into the receiver.

To prevent jamming other handsets:

- The rejection of the duplexer Rx filter in the Tx band and in other bands that may contain jammers helps protect against potential “jamming” signals outside the desired receive band.
- The rejection of the duplexer Tx filter at harmonics or other potential transmitted frequencies such as LO products can reduce the level of out-of-band signals transmitted by a handset.

Duplexer Transmit Filter

Passes Tx signal
Restricts noise leakage into Rx of same handset
May control some far out of band transmission artifacts (e.g. harmonics)



1. High rejection in Receive band (>40 dB min)

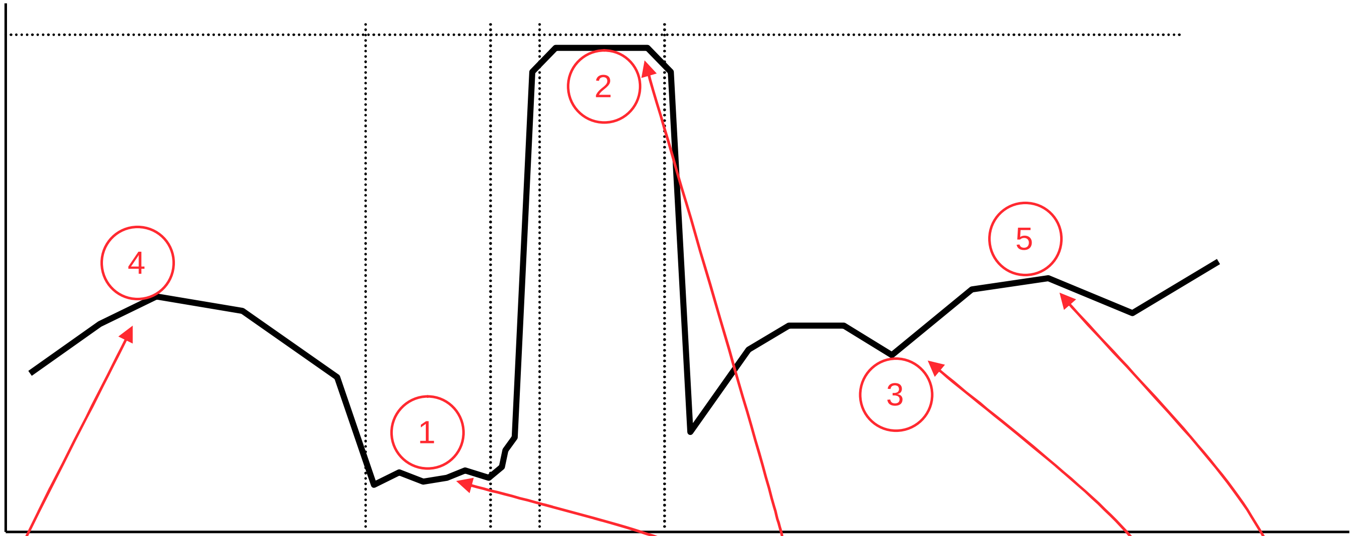
2. Low insertion loss in Transmit band (2-3 dB typ)

3. May have notches to suppress targeted signals, e.g. harmonics (20-30 dB typ)
4. Moderate rejection below Transmit band (20-30 dB typ)

5. Moderate to low rejection above receive band (5 to 30 dB typ)

Duplexer Receive Filter

Passes Rx signal
Blocks Tx signal from LNA
Blocks Out-Of-Band signals from LNA



1. High rejection in Transmit band (>50 dB min)

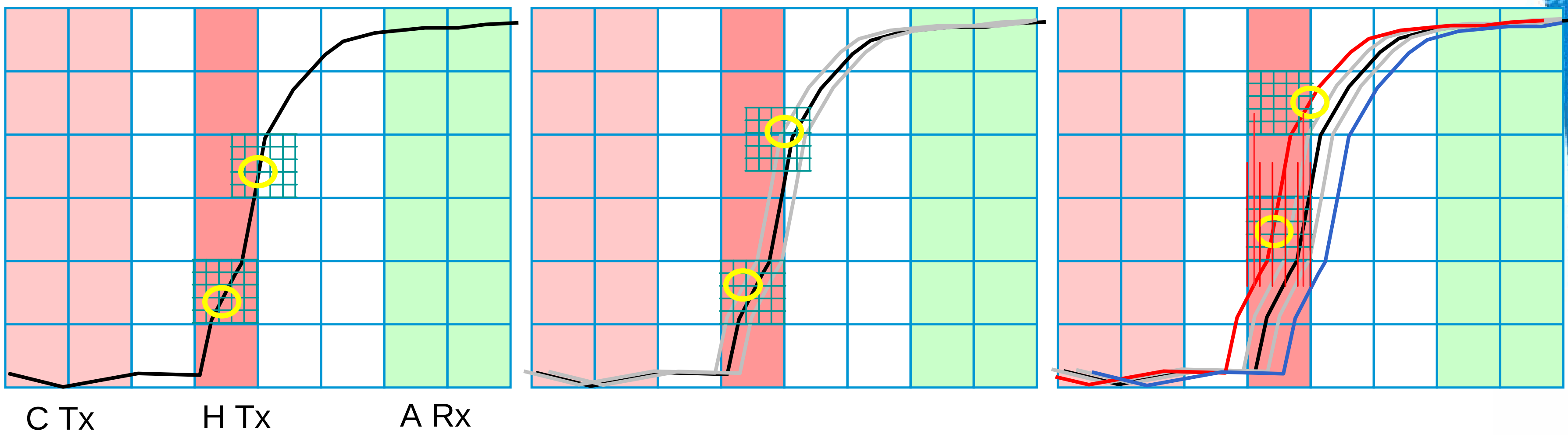
2. Low insertion loss in Receivet band (3-4 dB typ)

3. May have notches to suppress targeted signals, e.g. ISM band (20-30 dB typ)
4. Moderate rejection below Transmit band (20-30 dB typ)

5. Moderate ejection above Receive band (15-30 dB typ)

Protection from next generation FBAR filt

Curve is from prototype of ACMD-7402



Typical filter provides ~27 dB in H block at room temperature

Production variation across filters causes worst filters to provide ~20 dB at H block at room temperature

At hot temperature (+85 C), the worst filters may provide ~15 dB at H block

Next FBAR filters provide:

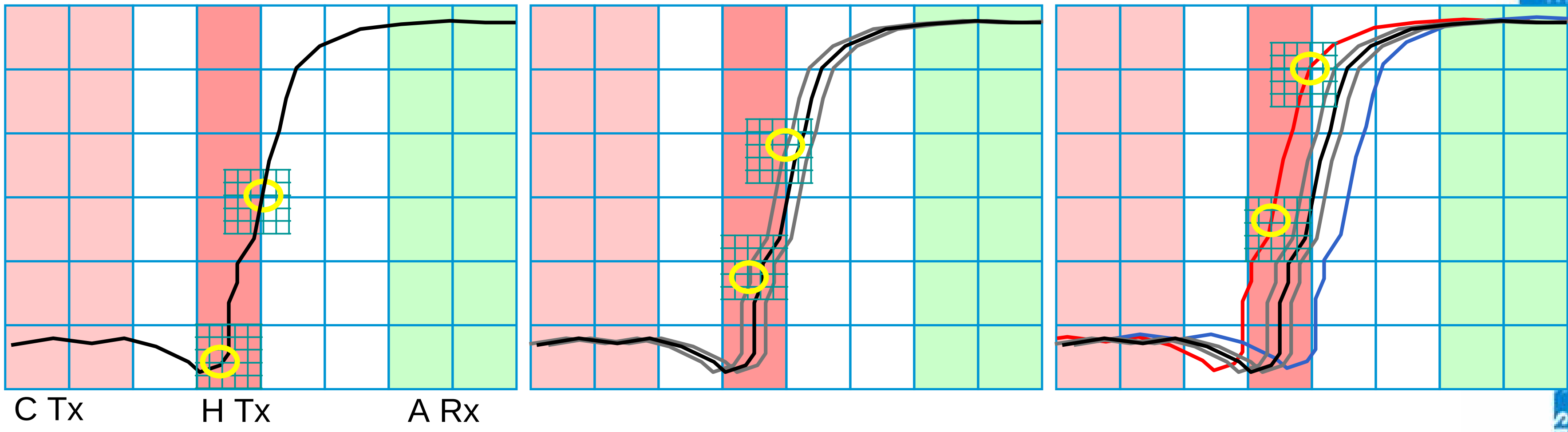
~ 15 dB rejection over temperature at top of H block (1920 MHz).

~ 36 dB rejection over temperature for the first 2 MHz of H block (1917 MHz).

Agilent estimates this duplexer will be used in US cdma phones by this Christmas.

Protection from ACMD-7401 FBAR filter

Curve is from data sheet of APMD-7401



Typical filter provides ~30 dB in H block at room temperature

Production variation across filters causes worst filters to provide ~22 dB at H block at room temperature

At hot temperature (+85 C), the worst filters may provide ~10 dB at H block

Present SAW filters provide:

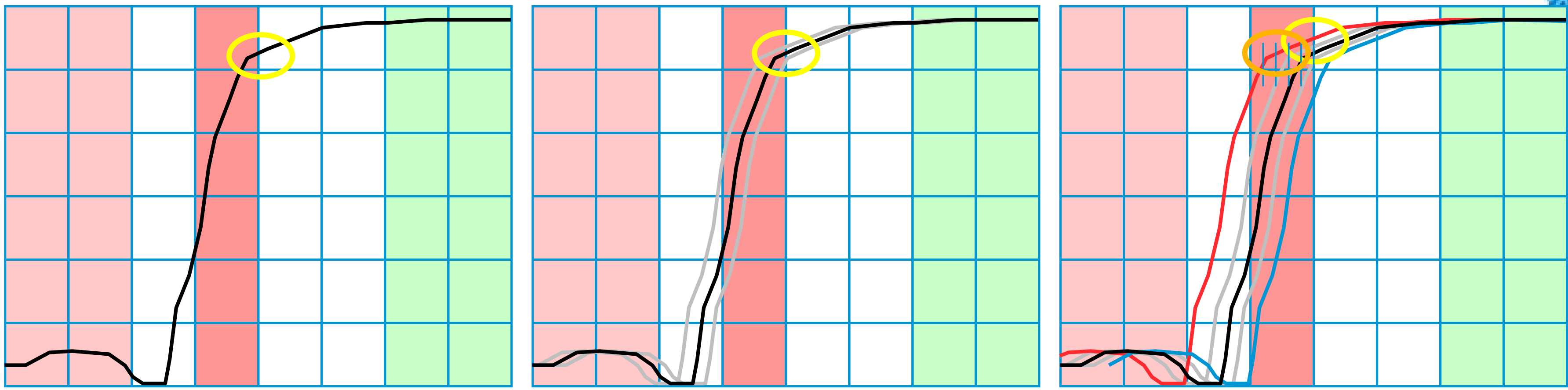
~ 10 dB rejection over temperature at top of H block (1920 MHz).

~ 30 dB rejection over temperature for the first 2 MHz of H block (1917 MHz).

Based on duplexer sales and subscriber statistics, Agilent estimates this duplexer is used in approximately 25% of phones presently used by US cdma subscribers.

Protection from HPMD-7904 FBAR filter

Curve is from data sheet of HPMD-7904



C Tx H Tx A Rx

Typical filter provides ~8 dB in H block at room temperature

Production variation across filters causes worst filters to provide ~6 dB at H block at room temperature

At hot temperature (+85 C), the worst filters may provide ~5 dB at H block

Present SAW filters provide:

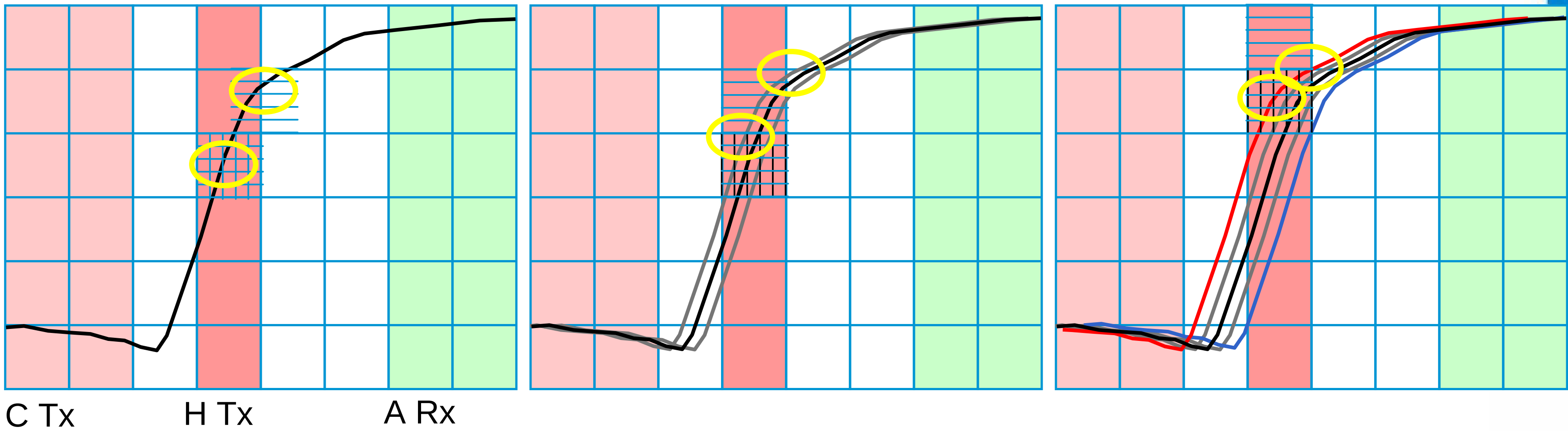
~ 5 dB rejection over temperature at top of H block (1920 MHz).

~ 8 dB rejection over temperature for the first 2 MHz of H block (1917 MHz).

Based on duplexer sales and subscriber statistics, Agilent estimates this duplexer is used in between 1/3 and 2/3 of phones presently used by US cdma subscribers.

Protection from present SAW duplexers

Curve is from measured performance of a Murata SAW Rx filter



Typical filter provides ~13 dB in H block at room temperature

Production variation across filters causes worst filters to provide ~11 dB at H block at room temperature

At hot temperature (+85 C), the worst filters may provide ~10 dB at H block

Present SAW filters provide:

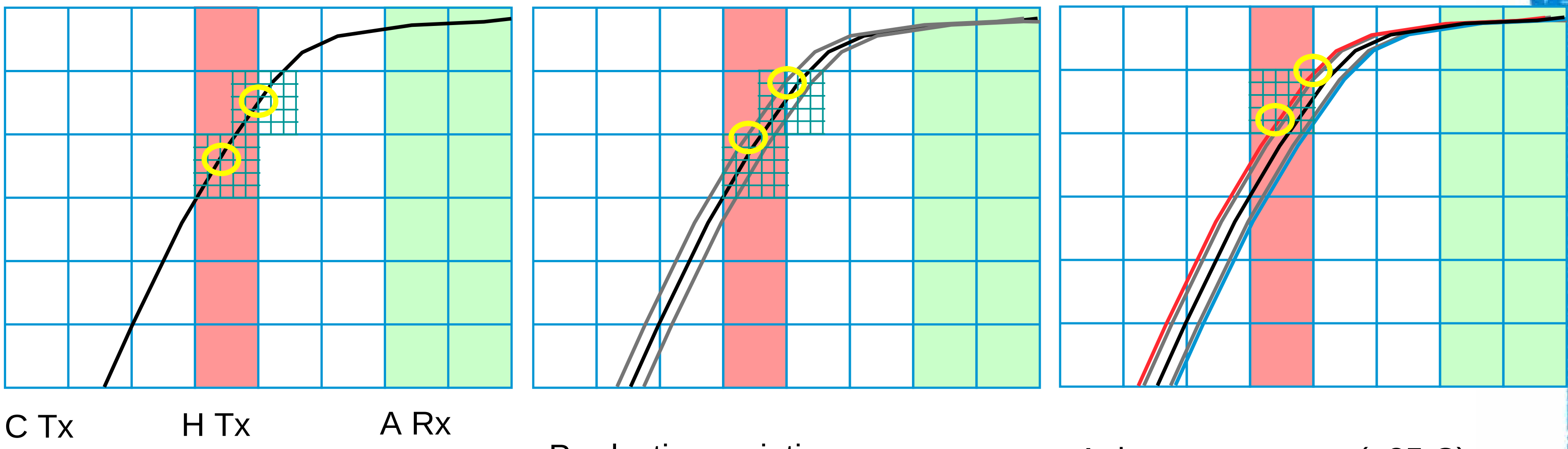
~ 10 dB rejection over temperature at top of H block (1920 MHz).

~ 14 dB rejection over temperature for the first 2 MHz of H block (1917 MHz).

Based on number of visible design wins, Agilent estimates this duplexer is used in approximately 10% of phones presently used by US cdma subscribers.

Protection from present ceramic duplexer

Curve is from data sheet of a CTS ceramic duplexer CER0111A2



Typical filter provides ~15 dB in H block at room temperature

Production variation across filters causes worst filters to provide ~12 dB at H block at room temperature

At hot temperature (+85 C), the worst filters may provide ~11 dB at H block

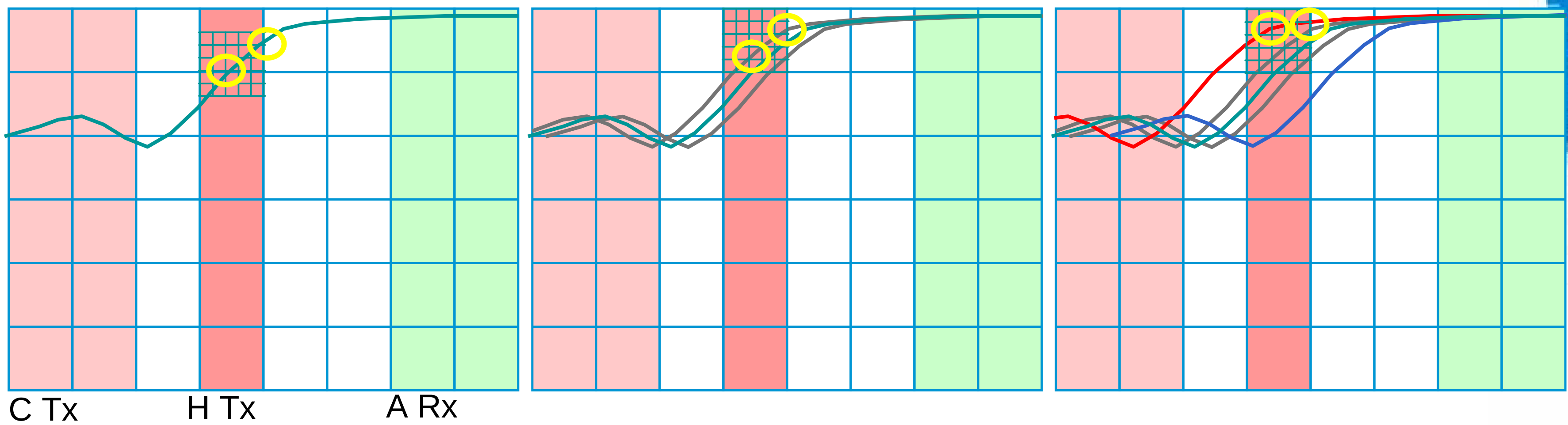
Present ceramic filters provide:

~ 11 dB rejection over temperature at top of H block (1920 MHz).

~ 19 dB rejection over temperature for the first 2 MHz of H block (1917 MHz).

Protection from present GSM SAW Filters

Curve is from data sheet of a Epcos SAW filter B9008



Typical filter provides ~6 dB in H block at room temperature

Production variation across filters causes worst filters to provide ~4 dB at H block at room temperature

At hot temperature (+85 C), the worst filters may provide ~2 dB at H block

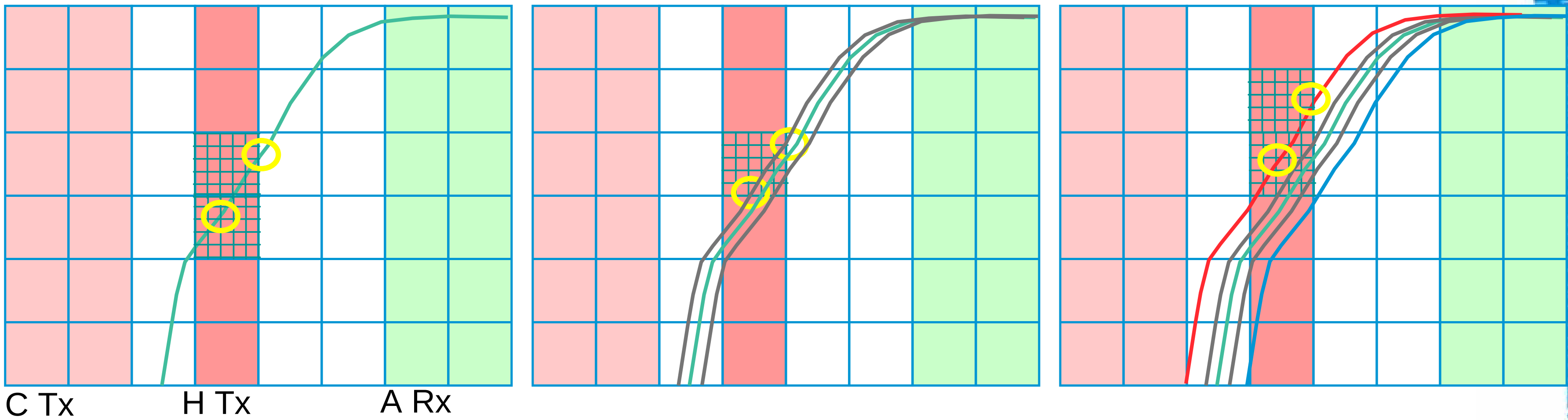
Present GSM SAW filters provide:

~ 2 dB rejection over temperature at top of H block (1920 MHz).

~ 3 dB rejection over temperature for the first 2 MHz of H block (1917 MHz).

Protection from simulated GSM FBAR Fil

Curve is from data sheet of a Epcos SAW filter B9008



Typical filter provides ~24 dB in H block at room temperature

Production variation across filters causes worst filters to provide ~22 dB at H block at room temperature

At hot temperature (+85 C), the worst filters may provide ~15 dB at H block

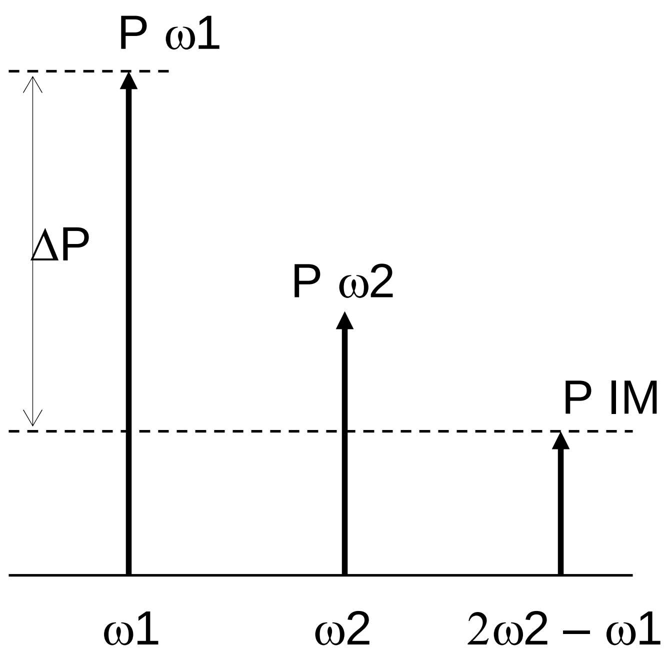
FBAR filters could provide:

~ 15 dB rejection over temperature at top of H block (1920 MHz).

~ 24 dB rejection over temperature for the first 2 MHz of H block (1917 MHz).

Intermodulation

Theoretical relationship between IM products and power levels for two unequal tones



$$\boxed{IIP3 = P\,\omega 2 + [\Delta P]/2}$$

$$\Delta P = P\,\omega 1 - P\,IM$$

$$IIP3 = P\,\omega 2 + (P\omega 1 - P\,IM)/2$$

or

$$P\,IM = 2\,P\,\omega 2 + P\,\omega 1 - 2\,IIP3$$